

migration period, nor does a cold spell mean a lengthening of the time over which the migration extends. Table 10 shows the difference of temperature of the migration day and that directly preceding it, and purports to prove that it is the temperature of the moment, not that which went before, which incites birds to migrate. It seems, however, as if the author had somewhat confused the issue; it cannot be the temperature at the point of arrival which incites the bird to begin its migration in spring. After this we have the various migration dates compared for Switzerland, Hungary, Bavaria, and Württemberg, though as the last has only three entries we think it might have been omitted.

In conclusion, the author indicates his conviction, which is probably shared by most ornithologists, that the real incentive to migration is not to be found in outward circumstances, but must be sought in physiological conditions. The outward conditions, including food, do undoubtedly have some effect upon it, but do not produce the necessary impulse. Though there is perhaps nothing startlingly new in this pamphlet, yet it is a welcome addition to the literature relating to migration; it shows much careful work, and the fact that Dr. Bretscher refrains from drawing more than very tentative conclusions adds to, rather than detracts from, its value. He realises that it is not possible to come to any definite solution of the problem he is studying without observations—and, we would add, meteorological data—made over a much wider field.

W. E. C.

CONTRIBUTIONS TO EMBRYOLOGY.¹

NO money given by Mr. Carnegie for the furtherance of scientific research is likely to yield better interest than that invested in the Department of Embryology in the Carnegie Institution of Washington, D.C. The nucleus of the department was formed by the collection of human embryos assembled by Prof. Mall when he held the chair of anatomy in Johns Hopkins University, Baltimore. It took Prof. Mall ten years to collect his first hundred specimens; five years to collect the second hundred; three years for the third; and two years for the fourth hundred. Since his collection was taken over by the Carnegie Institution four hundred specimens have been gathered each year. The collection of material is now the most extensive and the equipment the best of any embryological department in the world. Specimens are being gathered from all parts for the study of "racial embryology"—an untouched field of research. New technical procedures are being introduced to enable workers to reconstruct the different parts of the embryo with much greater accuracy than had been previously possible.

The two volumes here noticed contain an account of recent researches carried out by workers attached to the department of which Prof. Mall is the director. The director himself contributes

¹ "Contributions to Embryology." Vols. iv. and vi. (Carnegie Institution of Washington, 1916-17.)

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two papers—one on the origin of the "magma reticule," which is present in normal embryos, but is particularly abundant, as Giacomini had noted, in pathological human embryos. His second paper is a description of the condition of cyclops as seen in early stages of human development. Mr. R. S. Cunningham describes the development of lymphatics in the lung—a paper which is interesting not only from a theoretical, but also from a practical point of view. Dr. Florence Sabin gives an account of a prolonged series of investigations concerning the origin of blood-vessels, and reaches some unexpected conclusions regarding the earliest blood channels which appear in the head and brain. Certain channels which at first serve as veins appear afterwards to be converted into arteries.

All the papers represent a high grade of workmanship, and no pains or expense have been spared to obtain accuracy and finish of illustration.

A. K.

NOTES.

THE succession of M. Painlevé to the Premiership of the French Government ought, even in this country, to excite the interest and friendly sympathy of the scientific world. The new Premier is a member of the Paris Academy of Sciences, and a mathematician of world-wide reputation; besides contributing to the literature of his subject, he has held, until quite lately, two of the most important mathematical chairs in France. To construct a similar case in our own country, we should have to suppose our Prime Minister to be a man like the late H. J. S. Smith, or Sir William Ramsay; could anything more improbable be thought of? Yet the evidence is steadily growing that men of the so-called professorial type may show themselves eminently capable of directing public affairs; President Wilson is a conspicuous example, and as time goes on the number of such cases is certain to increase. We feel that, on behalf of English men of science, we may congratulate, not only M. Painlevé, but even France herself, on this appointment; and we confidently hope that the sequel will justify it, and help to make average citizens understand the value, in all national affairs, of a strictly scientific habit of mind.

UNDER the heading of "New German Chemical Discoveries," the *Times* of September 14 quotes from the *Neue Zürcher Zeitung* a review of German activities in technical matters in the field of war economics. It is stated that by the use of liquid sulphur dioxide viscous golden-yellow mineral oils are being extracted from coal; the yield, however, is small, 5 kilos. per metric ton. This is equivalent to about $1\frac{1}{4}$ gallons per imperial ton, and is a striking commentary on the shortage of such oils in Germany. The refining of petroleum oils by this solvent had already been placed upon a commercial footing under the Edeleanu patents, but the outbreak of the war interrupted the development of the process, which depends on the preferential solvent action of the liquefied gas on certain classes of hydrocarbons and sulphur compounds, enabling the removal of those which give rise to a smoky flame, together with the objectionable sulphur compounds. In a series of Howard lectures (Roy. Soc. Arts, 1916) Prof. Brame suggested the use of this solvent as being the most promising for the extraction of certain constituents of coal in future investigations; it is therefore of some interest to find that commercial application of liquid sulphur dioxide is now yielding these hydro-

carbon oils. A further quotation refers to the production of liquid hydrocarbons from naphthalene by heating under pressure with aluminium chloride. There is little novelty in this, for aluminium chloride has been very largely resorted to in the chemistry of hydrocarbon oils. It is stated also that a process has been discovered by which nearly twice the usual amount of ozokerite can be obtained from lignite distillation, but no indication of the method is given.

THE Deputy-Controller for Auxiliary Shipbuilding, Admiralty, has appointed Lt.-Col. J. Mitchell Moncrieff to be Director of Engineering Work, to deal generally with all civil engineering matters which may arise in connection with his department.

THE Board of Agriculture and Fisheries directs the attention of English nurserymen and other persons to the regulations issued by the Government of the Dominion of Canada which prohibit the importation of all five-leaved species of the genus *Pinus*, and also all species and varieties of currants and gooseberries into Canada. The importation of all pines and ribes (currants and gooseberries) into the United States of America has already been prohibited.

THE American Museum of Natural History has received a telegram from Mr. Donald B. MacMillan, leader of the Crocker Land Expedition, in which he gives an account of the latest discoveries made by his party. He defines the position of two new islands, and reports important surveys of the coast of Ellesmere Land. Two islands described by earlier expeditions cannot now be found in the positions marked on the charts. There has been discovered an enormous glacier, second only in size to the Humboldt. Mr. MacMillan has named it the American Museum Glacier.

THE seventieth birthday of Prof. S. Hoogewerff, formerly rector of the Technical High School of Delft, was recently celebrated by his friends and pupils. Prof. Holleman briefly reviewed Hoogewerff's work, carried out conjointly with the late Dr. Van Dorp, on the cinchona alkaloids, on *isoquinoline*, and on the production of anthranilic acid from phthalimide. The latter reaction became a step in the manufacture of synthetic indigo. On behalf of a number of Dutch chemical firms, Dr. Van Linge, manager of the Maarsse quinine works, announced that more than 8000l. had been subscribed for the foundation of a prize for chemistry at the Technical High School at Delft, in order to commemorate Prof. Hoogewerff's services to this institution and to Dutch chemical industry.

MR. HODGE, Minister of Pensions, stated to a deputation received by him on Monday that he proposed to take immediate steps to seek the necessary funds for the establishment of a National Experimental Laboratory which might ultimately become a national factory for manufacturing limbs. For the present, however, he was opposed to the establishment of a national factory. It was, in his view, essential that the Committee of Management of the National Laboratory should be small, representative of surgeons and mechanical experts, and distinct from any committee managing hospitals for limbless men. The Laboratory Committee would be directly responsible to the Ministry of Pensions, and would be empowered to ensure that the improvements which they recommended should at once be introduced into the manufacture of artificial limbs.

THE Indian Government is often called on to do curious pieces of work in connection with its policy of toleration towards the myriad religions of the Empire.

The route to the sacred temple at Badarinath, in the Lower Himalaya, has from time immemorial attracted large bodies of pilgrims. It starts from Hardwar, where the Ganges emerges from the hills into the plains, and is 338 miles in length. The route is also valuable, as it attracts a considerable trade from Gar-tok over the Niti Pass. The road was so dangerous, partly owing to damage suffered in the great flood caused by the rupture of the dam of the Gohna lake in 1894, that serious loss of life was annually reported. The Indian Government has now intervened, and by a grant from public funds, aided by a subscription from a Hindu merchant of Calcutta, this famous route has been realigned, improved, and provided with iron bridges to replace the former dangerous structures of bamboo ropes. The road is now open for pony traffic, and the new regulations secure the comfort of the pilgrims and proper sanitation.

IN the *Fortnightly Review* for September Viscount Bryce discusses a list of fourteen persons on whom the epithet "great" is usually conferred. He points out that there has been an element of chance in the bestowal of this title; some were second-rate men, and a good many of first rank have not received it. It has been bestowed on men of action rather than on men of thought, and no Shakespeare, Dante, Socrates, Bacon, Kant, Newton, or Leibniz appears in the list. All, except two Popes, have been rulers or conquerors; and moral excellence, nobility of soul, or devotion to duty has had little to do with the conferment of the honour of greatness. "To have founded a nation, as did Washington, to have saved a nation from disruption, as did Lincoln—these are achievements which make renown immortal. The epithet has ceased to be attached to famous names since the death of the last who received it—Frederick William of Prussia. But had it been given to any since his day, none would have deserved it better than these two, George Washington and Abraham Lincoln."

THE *Psychological Bulletin* (vol. xiv., No. 7) gives an account of the problems incident to the war which are of a psychological nature, and outlines the steps taken by a special committee in the United States to assist the military authorities with these problems. Problems suggested by military officers are referred by the committee to appropriate individuals or institutions for immediate attention, and the chief psychological laboratories of the country have been offered for such use as the military situation dictates. It is proposed to appoint a committee on psychology for the National Research Council, while special committees are to be organised to deal with various important aspects of the relations of psychology to the war, e.g. the psychological examining of recruits, the selection of men for tasks requiring special skill, psychological problems of aviation, problems of shock, re-education and vocational training, problems of recreation in the Army and Navy, problems of emotional stability, fear and self-control, acoustic and visual problems of military importance. It will be seen that the list is comprehensive, and it is asserted that already a new method of selecting officers devised by a psychologist is in use in many of the officers training camps. It is no longer a problem of inducing the American military authorities to accept methods of psychological measurement, but primarily one of meeting their expressed needs and requests for assistance.

ONE of the remaining unknown regions in tropical Africa was explored in 1915, when Major Cuthbert Christy made a journey along the Nile-Congo watershed on behalf of the Sudan Sleeping Sickness Commission. Major Christy contributes a paper on the subject, accompanied by a new map, to the *Geograph-*

ical Journal for September (vol. 1., No. 3). From the Lado Enclave north-westward to about lat. 7° N. the divide proves to be a continuous and more or less level strip of high country, covered with open savanna and in places as much as two miles in width. The fact that it is level and continuous makes this watershed important as a possible railway route, provided only that the unexplored northern part proves to have the same nature as the southern part. There is an ample water supply and plenty of good timber along the route. Major Christy suggests that a line should be built from El Fasher in Darfur, to which the Khartoum-El Obeid line is now being extended, along the Congo-Nile watershed to the Nile at Redjaf or Wadelai, and thence by the rift valley to Lake Tanganyika. This would be a longer but more practical route between Egypt and the lake region than the old project, which would entail almost insuperable difficulties in the sudd regions of the middle Nile. The map accompanying the paper is based on a prismatic compass traverse. No astronomical observations were taken.

It is announced by the *Times* that Sir Arthur Steel-Maitland, Under-Secretary for the Colonies, will be the Parliamentary Secretary of the new department which is being created to improve our commercial intelligence system, and that his successor at the Colonial Office will be Mr. W. A. S. Hewins. The Commercial Intelligence Department will eventually comprise the existing Department of Commercial Intelligence of the Board of Trade and the Foreign Trade Department of the Foreign Office, and will take over such of the staff and records of the War Trade Intelligence and Statistical Departments as may be available and required. The official head of the department will be an officer appointed jointly by the President of the Board of Trade and the Secretary of State for Foreign Affairs, working under the new Parliamentary Secretary. The appointment and control of the Trade Commissioners within the Empire will, as at present, rest with the Board of Trade, and the appointment and control of the Commercial Attachés and Consular Service with the Foreign Office, but the work of the new department will comprise all matters dealing with commercial intelligence, and, so far as is necessary for that purpose, it will give directions to the overseas services and make the necessary arrangements for keeping them in close touch with the commercial classes in this country. The department will be assisted by an Advisory Committee of business men, and it is hoped that it will be possible to arrange for a sub-committee of this committee to meet at frequent intervals in order to advise the department on its current work.

A CORRESPONDENT of the *Pioneer Mail* of August 11 shows that there are still some unexplored byways in the study of the animals of India. The lion is believed to be now confined to the Gir forest of Kathiawar, but news has been received of the discovery of the skin of an animal supposed to be a lion in Assam. In the Khasia Hills there were said to be animals like small pigs, but with feet like dogs. These have now turned out to be badgers. The one-horned sheep of Nepal was at one time regarded as fabulous, but ten years ago it was found to be a fact, and the writer states that he possessed two specimens, one of which was sent to the experimental farm at Shillong, where it probably may still be examined.

THE alertness of the United States Bureau of Fisheries and the thoroughness of its operations are well illustrated in the issue of *California Fish and Game* for July, where Mr. J. N. Cobb directs attention to the wholesale waste of fishery products which could well be turned to profit. In the salmon fisheries of the

Pacific coast, he remarks, 140,000,000 salmon were taken during 1913. The preparation of these fish for the market resulted in the loss, in the form of offal, of no fewer than 101,186 tons, all of which could have been "worked up into merchantable products." Millions of pounds of salmon eggs, now run to waste, could, he insists, be converted into caviare. In Siberia during this year no fewer than 259 tons of such eggs were thus prepared, as against 24,000 lb. on the Pacific coast of America. The rest of the offal, he suggests, should be converted into fertiliser and oil. Alaska harbours enormous numbers of trout, representing four species, all of which could be canned, as are the salmon further south. No less neglected, he shows, are various species of the Mollusca and Crustacea. He also advocates the use of whale meat and the skins of hair seals for leather. Finally, he points out, there are great possibilities for the use of the various kinds of seaweed. These we in this country could also profitably adopt.

THE gipsy moth, *Porthetria dispar*, was accidentally introduced from Europe into Massachusetts in 1868, and is now widely spread throughout eastern New England, where the caterpillars annually defoliate and kill many broad-leaved trees. The State of Massachusetts has spent more than 1,000,000 dollars in unsuccessful efforts to exterminate this pest, which does so much damage to shade and fruit trees. It has lately invaded the forests, attacking especially oak, aspen, poplar, beech, lime, and birch. It is impossible, on account of the expense, to have recourse in the forests to the spraying methods which are useful in orchards and city avenues. Messrs. G. E. Clement and Willis Munro, in U.S. Dept. of Agriculture Bulletin, No. 484, give the results of their investigations as regards the liability of the various forest trees to attack, and propose certain measures of defence, which depend mainly on the elimination by felling of species sought after by the larvæ, and on the cutting of dead and dying trees generally. In this region the problem is complicated by the presence of two other exotic plagues, the chestnut-bark disease, supposed to have been introduced from Japan, and the white pine blister rust, which was imported with nursery stock from Germany. These two fungoid diseases are so serious as to endanger the continued existence in the United States of two valuable timber trees, the chestnut and the white pine.

THE seat of the olfactory sense in spiders, hitherto a matter of speculation, seems to have been determined, at least in the trap-door spiders, by Mr. John Hewitt, who describes his investigations on living spiders in the *South African Journal of Science* for March, which has just reached us. From Mr. Hewitt's experiments with scent-tipped rods there appears to be no doubt that this sense is located in the feet, and more directly, perhaps, in the "scopula"—the pad of fine and specially modified hairs seated on the lower and lateral surfaces of the tarsi. Whether females lack this sense or not is a matter for conjecture. At any rate, they do not respond to the tests which so readily stimulate the males into action. The author suggests that it is by the sense of smell that the males find their mates. If this be so, then it would appear that the females remain odourless during their periods of sexual inactivity, for males used in these experiments showed no sign of response when placed near females. When placed on a tablecloth having a woolly surface males at once adopted the characteristic courting attitude, the appropriate movements being apparently stimulated by the likeness of the fibres of the cloth to the threads set free by the female in her immediate neighbourhood when desirous of mating, at which time the male also

releases threads from the spinnerets. Mr. Hewitt's observations, though briefly stated, are sure to attract the attention, not only of students of the Arachnida, but also of all who are interested in animal behaviour.

MR. G. F. BECKER (United States Geological Survey, Professional Paper 98—N) investigates the "Mechanics of the Panama Canal Slides," and concludes that "a limit is set to the vertical height of a cliff or [of?] any rock." This limit allows a face of 3700 ft. in granite, which is well above that of El Capitan in the Yosemite Valley. When breaks have opened parallel to the rock-face, a horizontal shear has started at the base of the cliff, and outward movement can be checked only by the removal of material and the sloping back of the surface of the unstable mass.

WE have received a copy of a publication of the Carnegie Institution of Washington entitled "A History of Transportation in the United States before 1860." The large volume, which is the work of many authors, has been put together and edited by Miss C. E. MacGill. The development of transportation is traced from the trails of the earliest settlers, through later roads, turnpikes, and canals, to modern railways. The study is mainly historical and economic, but the geographical point is not lost sight of, particularly in the chapters on the early trails and on the canals and waterways. Coloured maps show the navigable rivers of the United States, the canals, and the railways in operation in 1840, 1850, and 1860. There is a bibliography of several hundred entries and a full index.

THE United States Coast and Geodetic Survey celebrated the centenary of its commencement on April 5 and 6, 1916, and the addresses which were then delivered have been recently published by the Survey. These addresses summarise the past work of the Coast and Geodetic Survey in the fields of geodesy, verification of standards, terrestrial magnetism, hydrography, tidal investigations, etc. They give a convenient summary of the work which has been accomplished, and we notice that throughout its history the Survey has always given a prominent place to investigation and research, while the design and improvement of instruments for the execution of the highest class of geophysical operations have been kept in mind, and much has been done in this direction.

WHEN the new Swedish State Museum of Natural History was opened to the public the palæobotanical department was not complete, owing to the illness of Prof. Nathorst. The collection, which, besides fossil plants, contains also the recent Archegoniates, has now been arranged in its new quarters, which are appropriately adorned by busts of A. E. Nordenskiöld and Oswald Heer, as well as by coloured pictures of past floras. The small collections of fossil plants which belonged to Swedenborg, Per Hasselquist, Hisinger, and others are kept together for the sake of their historical interest. The remaining exhibited fossils are arranged in two series. One, in cases along the walls and by the windows, is systematic, and represents the morphological development. The divisions adopted are: Equisetales, Pseudoborniales (a group hitherto found only in the Upper Devonian rocks of Bear Island), Lycopodiales, Filicales, Pteridospermeæ, Cycadophyta, Ginkgoales, Cordaitales, and Coniferales. The other half of the collection is arranged stratigraphically, and occupies several cases in the middle of the hall. The main study-series are in other rooms. Thanks to the energy of Prof. Nathorst, all these series are not only remarkably rich, but also of high scientific value from both the geological and the botanical aspect, and it is needless to add that the department is fully provided with laboratories and all that is required for the care of so important a collection.

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IN order to release part of the large quantity of grain used in distilleries and to augment the food supplies of the country a reduction of the amount of potable spirits produced has been enforced. One of the consequences of this restriction was the curtailment of the output of yeast available for bread-making. To meet this possible difficulty Mr. Julian L. Baker was asked by the Royal Commission on Wheat Supplies as to the possibility of using brewers' yeast for the purpose. The results of his investigations are published in the Journal of the Society of Chemical Industry for July 31. The conclusions drawn are: (1) That a mixture of distillers' yeast and brewers' yeast (from any part of the United Kingdom) will effect a satisfactory fermentation of dough, the brewers' yeast being contributory to the fermentation and not merely a diluent; (2) that, using a mixture containing 33 or 50 per cent. of brewers' yeast, the doughing period will be slightly prolonged (about 20 per cent.) if the yeast rate is low; (3) that brewers' yeast alone is useless in the ordinary "quick doughing" process, but with it good loaves can be made of a "slow dough"; (4) that a deficit in the supply of distillers' yeast to bakers could be met by means of brewers' yeast within certain limits; (5) that brewers' yeast alone will produce palatable loaves; and (6) that with the present output of beer 200 to 250 tons of brewers' yeast per week would be available for bakers at a much lower price than that paid for distillery yeast, of which 700 tons are used weekly. In order to avoid the risk of imparting a yeasty and bitter flavour to the bread, the brewers' yeast should be washed with a dilute solution of salt and then submitted to a short, brisk fermentation in a dilute mash-tun wort. Mr. Baker is of the opinion that bakers could use a mixture of equal parts of brewers' and distillers' yeast without any serious inconvenience to their trade or disadvantage to the public.

THAT caustic soda solutions at temperatures in the neighbourhood of 100°C. produce brittleness in soft steel has long been known and has been the subject of several investigations. No satisfactory explanation has yet been reached, and the matter has been recently taken up by Prof. S. W. Parr and further investigated. The account of his work is published in Bulletin No. 94 of the Engineering Experiment Station of the University of Illinois. That the embrittling effect of caustic soda is due to the evolution of hydrogen and its absorption by the steel in the nascent state is generally conceded. The author shows that during the action of the alkali at 100°C. the electrical potential of the steel is considerably raised, and that it extends from the surface into the specimen for a distance of, at any rate, 0.30 in. This increase is also brought about by immersion in dilute acids and by cathodic polarisation. The potential is in all cases higher after treatment of any sort that evolves nascent hydrogen, and this fact points to the occurrence of a molecular change in the steel. This high potential disappears in many cases after a lapse of time, and after heating to from 100° to 200°C. in air, but no relation was established between its presence and the existence of brittleness. Indeed, the author states that the potential increased long before brittleness was manifested. By using sodium dichromate as a depolariser in the caustic soda solutions the author found that the rate of corrosion at 280°C. was much diminished, and that the toughness of the steel, as judged by the repeated bending test, suffered no deterioration. A complete explanation of the cause of brittleness is still to seek.

IN Bulletin No. 95 of the Engineering Experiment Station of the University of Illinois Messrs. Yensen and Gatward describe the results of a research on the properties of iron-aluminium alloys. The alloys were

made in magnesia crucibles heated in an Arsem vacuum furnace by melting pure iron and afterwards dropping in aluminium, the latter being suspended in the form of wire or rod from a very fine wire extended between insulating posts which passed through the cover of the furnace. At the required moment this was fused. In this way alloys containing up to 13 per cent. of aluminium were obtained, and are stated by the authors to be less contaminated with impurities than any previously made. The alloys classed as uncontaminated contain from 0.01 to 0.02 per cent. of carbon. Other alloys containing more carbon are classed as contaminated and are used to show the effects of carbon. Aluminium is a more powerful deoxidiser than silicon and does not commence to combine with iron until all the oxides present have been reduced. It forms solid solutions with iron throughout the range studied. The alloys have been studied chiefly from the point of view of their magnetic properties. Aluminium, like silicon, has a beneficial effect when added in small quantities. The best alloy obtained, containing 0.4 per cent. of aluminium, has a maximum permeability above 35,000 when annealed at 1100°C. The hysteresis loss for B. max. = 10,000 and 15,000 is 450 and 1000 ergs per c.c. per cycle respectively. The specific electrical resistance increases, about 12 microns for each per cent. of aluminium added up to 3 per cent. Above this the rate of increase falls off gradually.

OWING to the shortage of superphosphate prepared in the ordinary way with sulphuric acid various suggestions have been made to supply the deficiency (such as the action of nitre-cake on rock phosphate), or to use what ordinary superphosphate there is available to the greatest advantage. For the latter purpose admixture with insoluble phosphate has been advocated. Concerning this proposal, the results obtained by Mr. G. Scott Robertson (Journal of the Society of Chemical Industry, June 30) are of considerable importance. Mr. Robertson finds that when ordinary superphosphate is mixed with basic slag the greater part of the water-soluble calcium phosphate contained in the former reverts to the insoluble form almost at once by the action of the free lime in the basic slag, whilst on keeping the mixture a slower change in the same direction is observed. Thus when a superphosphate containing 26 per cent. of water-soluble calcium phosphate was mixed with an equal quantity of basic slag (containing 1.7 per cent. of free caustic lime), the mixture, instead of containing 13 per cent. of water-soluble phosphate, contained only 5 per cent. immediately after mixing, and only 2.8 per cent. after keeping for fourteen days, after which period the composition altered but slightly. When the basic slag is replaced by an equal proportion of natural rock phosphate there is a much smaller reversion, so that there is no serious objection to such a mixture being used by farmers. A mixture of Gafsa rock phosphate with an equal weight of superphosphate contained 12.7 per cent. of water-soluble phosphate (instead of 13 per cent.) immediately after mixing, and 10.4 per cent. at the end of fourteen days. Gafsa phosphate (which rarely contains more than 0.75 per cent. of calcium oxide in the form of free carbonate) is probably the most suitable for mixing with superphosphate. Then come Egyptian phosphate, Florida pebble phosphate, Makatea Island phosphate, and Tunisian and Algerian phosphates, in order of suitability.

THE Scottish Motor Traction Company, which runs a number of motor omnibuses in Edinburgh and the district, has taken up the use of coal-gas as a substitute for petrol, and a photograph of one of its

vehicles appears in the *Engineer* for September 14. The gas-holder consists of a large flexible container, which covers the entire roof of the vehicle, the arrangement being similar to that adopted in other vehicles of this type. The simplicity and low cost of the flexible receiver charged with gas at low pressure warrant careful consideration of the system as a war measure. Although the quantity of gas which can thus be carried is limited, this disadvantage is to some extent compensated for by the ease with which the gas-holder can be recharged. Further, high-pressure receivers are not easy to procure at the present time. Owing to the low pressure—about 0.2 in. of water—a meter delivering into the receiver races unless some form of throttle is interposed. A short length of small-bore piping, or a diaphragm with a suitable aperture, is recommended so as to retain the pressure drop in the meter within reasonable limits.

WRITING in the *Tohoku Mathematical Journal*, vol. xi., 3, Mr. Hastime Tanate discusses the logical foundations for negative and imaginary quantities and expresses the view that the existence of these quantities may be explained independently of any geometrical considerations.

OUR ASTRONOMICAL COLUMN.

DISTRIBUTION OF SPIRAL NEBULÆ.—The distribution of spiral nebulæ has been further investigated by Dr. R. F. Sanford, with the aid of photographs obtained with the Crossley reflector (Lick Observatory Bulletin, 297). The photographs were taken with exposures of the order of twelve hours, the object being to find out whether new nebulæ could be detected in regions of the Milky Way which have hitherto seemed barren of them. They afford no evidence of undiscovered faint nebulæ in the regions where they have not previously been found with shorter exposures. It is shown that there is greater average brightness for the extra-galactic than for the galactic spirals, and that the nebulæ which lie nearest to the Milky Way are on the average of larger angular size than those away from it. F. G. Brown has shown that the larger nebulæ in general are the brighter, but this is not true of spiral nebulæ near the Milky Way, which are large and faint. Thus, if angular size be taken as a criterion of distance, it follows that something cuts off the light from the galactic spirals, thereby letting only the nearer ones be perceptible, and then only with diminished brightness. An arbitrary and general distribution of the spiral nebulæ can be best harmonised with the observed features of the distribution by assuming the existence of an obstructing medium, which is irregularly scattered throughout the galaxy. It is considered probable that the spirals are not only outside our own system, but that they can have no intimate connection with it dynamically.

THE GREAT SOLAR PROMINENCE OF 1916, MAY 26.—A detailed account of the great eruptive prominence of 1916, May 26, which reached a maximum height of half a million miles, and in some parts attained a velocity of 457 km. per second, has been given by Mr. Evershed (Kodaikanal Bulletin, No. 55). One of the most striking results of the measurements of the photographs is to show that all parts of the prominence were moving radially outwards from a point in the chromosphere at the base of the main column. It is considered probable that an eruptive prominence begins as an unusually dense low-lying mass of gas which may persist without much change for several days, and then suddenly become unstable, becoming subjected to a force which tears it to shreds and sends the frag-